STANDARD OPERATING PROCEDURE 1.01
CALIBRATION OF SCALER/RATEMETERS

1. PURPOSE

To provide a standard method for the calibration of scaler/ratemeter instruments.

2. DISCUSSION

A scaler/ratemeter (meter) is used with a compatible probe/detector (detector) to measure radiation in rate and/or integrated scaler count modes. A meter is calibrated using a pulse generator, also known as a pulser. The pulser allows for the high voltage, threshold, window setting and digital/analog count rate to be tested.

3. PROCEDURE

3.1 Equipment

3.1.1 Portable meter: Ludlum Model 3, 12, 177, 1000, 2000, 2221, 2224, 2241, 2360, 2929, 3030 or equivalent.

3.1.2 A calibrated Ludlum Model 500 pulser.

3.1.3 Cable: C-C or other connectors, as applicable.

3.1.4 Flathead precision screwdriver.

3.1.5 Documentation

3.1.5.1 Obtain a blank Certificate of Calibration form for the appropriate instrument.

Note: Sample copies are included in this SOP as attachments. The most current calibration forms are on file, contained in the equipment database, or can be obtained from the equipment manager.

3.2 Calibration Procedure

3.2.1 Check the mechanical features including knobs, buttons, reset, audio and battery level for functionality. Check off the calibration form appropriately.

3.2.2 Connect the pulser to the meter being calibrated.

3.2.3 Check the high voltage at 500, 1000, 1500 volts to see if the meter readings matches the pulser readings. If so, then check the appropriate line on the calibration form. If the readings do not match, then refer to the Ludlum manual for that particular instrument on how to adjust the HV.

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3.2.4 If applicable, determine if the threshold and window features are operating correctly. Not all meters will have a Window. Most will have a Threshold. On a few meters the Threshold is not adjustable.

3.2.4.1 Determine what the Threshold (THR) and Window (WIN) settings are on the meter. Use the THR and WIN buttons that display the settings when pressed. The window and thresholds are set according to which detector will be used with the meter.

3.2.4.2 By adjusting the amplitude on the pulser, check to see if the set displayed Threshold and Window settings correspond to the actual settings. If so then check the appropriate line on the calibration form. If it does not, refer to the manufacturer's manual.

3.2.5 Set the scale multiplier on the meter and check the ranges indicated on the appropriate calibration sheet. Set the count rate on the pulse generator to its highest reference setting indicated on the calibration sheet. Observe and record the instrument analog and/or digital reading. Repeat this for the remaining reference settings. Record this value in the "As Found" column. If the reading is not +/- 10% of what the pulser reads then use a precision screwdriver to adjust the appropriate potentiometer so the meter reading matches the pulser output. If unfamiliar with this process then refer to manufacturers manual.

NOTE: As the count rate and range setting are changed on the pulser, allow time for the meter analog needle movement to respond. It may take a few seconds for this to happen, especially if in slow response mode.

3.2.6 If the meter has the ability to take integrated counts (i.e., ability to collect counts for a set time span, for example: one minute) then perform a one-minute integrated count check and log scale check and record readings in the appropriate columns on the calibration form.

4. TRAINING

4.1 Prior to performance of calibrations, all personnel must show proficiency in the operation of the meter to be used.

4.2 Prior to performance of calibrations, all personnel must show proficiency in use of the calibration forms.

4.3 Prior to personnel being assigned to the field, supervisor must sign off of the Training Qualifications Form that he/she met requirements 4.1, 4.2, above.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.03)

5.2 Computer generated files will be saved as hard copies and stored with equipment folders.

6. REFERENCES

6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

ERG SOP 4.03

Form 4.00 Training Qualification Form

7. ATTACHMENTS

7.1 Dual Channel Calibration Form

7.2 Single Channel Calibration Form

7.3 2929 & 43-10-1 Calibration Form

Author's Signature:	**Reviewed By:**
Charles P. Farr	Kenneth R Baker

STANDARD OPERATING PROCEDURE 1.04
HIGH ENERGY GAMMA SCINTILLATION DETECTOR CALIBRATION AND CHECKOUT

1. PURPOSE

To describe the procedures for calibration and operational check-out of high energy gamma scintillation detectors employing ERG Standard Operating Procedures

2. DISCUSSION

This procedure applies to the Ludlum Model 44-2, 44-10 and 44-20 high energy gamma scintillator or equivalent.

3. PROCEDURE

3.1 Equipment

3.1.1 Portable ratemeter-scaler: Ludlum Model 3, 12, 2221, or equivalent.

3.1.2 Gamma detector: Ludlum 44-2, 44-10, 44-20, or equivalent.

3.1.3 Cable: C-C or other connectors, as applicable.

3.1.4 Record Forms: ERG Form 1.03A.1

3.1.5 Calibration source, typically a Cs-137 button source

3.1.6 Calibration Jig

3.2 Instrument/Detector Assembly and Electronic Set-Up (Calibration)

3.2.1 Attach the gamma detector to a portable ratemeter-scaler

3.2.2 Turn the instrument to the HV position. Note condition of battery as indicated by display. If the battery power is marginal, the batteries should be replaced.

3.2.3 Adjust the threshold setting on the ratemeter/scaler according to the users manual. Threshold for a Ludlum gamma scintillator is typically 10 mV.

3.2.4 Construct a Plateau Curve.

The operating voltage is determined based on the characteristics of a plateau curve. Curves are constructed every twelve months, after major repairs to a detector, and when a new detector is received. The plateau curve data are kept on file.

3.2.4.1 Place the detector in the calibration jig with the source in place.

3.2.4.2 Turn the high voltage down, then gradually increase the voltage until the meter begins to register counts. The speaker unit may now be turned off

3.2.4.3 Accumulate counts for 1-minute.

3.2.4.4 Record voltage setting and count rate. (ERG Form 1.03A.1)

3.2.4.5 Increase voltage to net higher multiple of 50 V.

3.2.4.6 Accumulate counts for 1 minute and record voltage and count rate.

3.2.4.7 Repeat 3.2.4.5 and 3.2.4.6 until the count rate begins to increase rapidly with increased voltage. The voltage should not exceed 1200 volts.

3.2.4.8 Prepare a graph of count rate vs. voltage. This graph should consist of a relatively flat section where there is little increase in count rate over a voltage range of up to several hundred volts. This voltage range is called the plateau region of the detector.

3.2.4.9 Select a voltage above the knee of the plateau region and indicate the value on the graph. Adjust the instrument voltage to this setting. Accumulate a background count for 1 minute and record. See Figure 1.03A

4. TRAINING

4.1 Prior to performance of calibrations or use in the field, all personnel must show proficiency in the operation of the high-energy gamma scintillation detectors.

4.2 Prior to use in the field, all personnel must show proficiency in use of the calibration forms.

4.3 Prior to use in the field, all personnel must show proficiency in and understanding of the MDA formula.

4.4 Prior to personnel being assigned to the field, a supervisor must sign off of the Training Qualifications Form that he/she met requirements 4.1-4.3 above.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.03)

5.2 Computer generated files will be saved as hard copies and stored with equipment folders.

6. REFERENCES

6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 1.30

Form 4.00 Training Qualification Form

7. ATTACHMENTS

7.1 Form 1.03A.1 – Voltage Plateau

7.2 Figure 1.03A – Plateau Curve

Author's Signature:	**Reviewed By:**
Charles P. Farr	Kenneth R Baker

STANDARD OPERATING PROCEDURE 1.13
HIGH PRESSURE IONIZATION CHAMBER SETUP AND OPERTATION

1. PURPOSE

The purpose of the procedure is to instruct the user on how to properly setup and operate a High Pressure Ion Chamber (HPIC) to make gamma radiation exposure measurements

2. DISCUSSION

This procedure applies to the GE-Energy (formerly Reuter-Stokes) HPIC Model RSS-131, or equivalent.

3. PROCEDURE

3.1 Equipment

3.1.1 High Pressure Ion Chamber and tripod.

3.1.2 Cable.

3.1.3 Computer.

3.2 Setup

3.2.1 Load the RSS-131 software to laptop or desktop using the provided CD

3.2.2 Connect HPIC to laptop using RS232 cable.

3.2.2.1 Connect round 8-pin connector to COM Port 4 on HPIC

3.2.2.2 Connect DB-9 serial connector to COM 1 on computer.

3.2.3 Open RSS-131 Configuration Utility on computer.

3.2.3.1 From the configuration Utility you can change the HPIC settings such as logging time, format, etc. Refer to the RSS-131 manual for more details.

3.3 Operation

3.3.1 The HPIC logs reading whether or not it is connected to a computer. You can turn the detector on/off as needed between locations.

3.3.2 When the HPIC is initially turned on, the exposure rate readings will spike. After approximately 2-3 minutes the readings will have stabilized.

3.3.3 After the stabilization period, the HPIC will continue to collect readings according to the logging settings. The collection period should be defined by project specific instructions, but is typically 10 to 20 minutes per location.

3.3.4 At each location, the date, location, collection start and stop time should be noted in the field log book.

3.4 Downloading data

3.4.1 Upon completion of data collection, the data can be downloaded to a computer. Connect the PC to the HPIC according to section 3.2 or the HPIC User's Manual.

3.4.2 Open the Utility program, from the Online menu select the 'Upload sensor data from RSS-131' option. The data can be downloaded in .csv format. The data can be viewed, managed and displayed in Microsoft Excel.

4. TRAINING

4.1 Prior to use in the field, all personnel must show proficiency in the operation of the HPIC and associated computer program utilities.

4.2 Prior to personnel being assigned to the field, supervisor must sign off of the Training Qualifications Form that he/she met requirements 4.1 above.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.03)

5.2 Computer generated files will be saved as print and/or electronic files and stored with field notebooks and/or equipment folders or files.

6. REFERENCES

6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 4.03

Form 4.00 Training Qualification Form

7. ATTACHMENTS

7.1 No Attachments.

Author's Signature:	**Reviewed By:**
Charles P. Farr	Kenneth R Baker

STANDARD OPERATING PROCEDURE 1.30
FUNCTION CHECK OF EQUIPMENT

1. PURPOSE

To describe the procedures for operational check-out and function check of radiation detectors and meters prior to collecting data.

2. DISCUSSION

The site manager is responsible for assuring that this procedure is implemented. The survey team members are responsible for following the procedure. It is imperative that the equipment is properly function checked each day of use and documented.

3. PROCEDURE

3.1 Equipment

3.1.1 Ratemeters and/or Scalars including Ludlum Models 2221, 2241, 3, 12, 19, 2360, or equivalent

3.1.2 Detectors including Ludlum models 44-10, 44-9, 44-2, 44-116, 43-5, 43-89, 43-93, or equivalent

3.1.3 Cable: C-C or other connectors, as applicable

3.1.4 Record Forms: ERG Form 1.30A (single channel detector) or 1.30B (dual channel detector)

3.1.5 Radiological check sources, typically Th-230 (alpha), Tc-99 (beta), and/or Cs-137 (gamma) sources

3.1.6 Calibration Jig

3.1.7 Instrument Manuals

3.2 Initial Instrument Field Check Out.

3.2.1 The following instructions should be followed unless otherwise directed by Project Manager.

3.2.2 Create a Function Check Form for each piece of equipment being used. Record serial numbers, calibration dates, and check source information in the appropriate fields. Under comments, record source to detector distance, site name, and location on site where function check is performed.

3.2.3 Check the instrument to assure that the settings are consistent with the calibration data. This means the Battery, High Voltage, Threshold, and Window Settings must be set

according to those used in the original calibration or set up. Check with the Project Manager if in doubt or if changes are necessary for site specific reasons.

3.2.4 Replace the batteries in the meter if they indicate that they are near the low voltage level. Record all settings including the battery voltage on the Function Check Form.

3.2.5 With the meter in the rate meter position and a meter scale selected so that the meter is not pegged (other than the log scale), move both ends of the detector cable to determine if the cable is functioning properly. A faulty cable will introduce spurious counts. To test a cable, move both ends of the cable watching the meter. If excessive counts occur the cable may be faulty. Replace with a new cable of identical size and repeat the test. Document faulty cable and dispose of cable.

3.2.6 Select a location to perform the function check. This location should be selected with the following conditions in mind:

3.2.6.1 The location should represent background conditions for the site.

3.2.6.2 The radiological conditions surrounding the location should be expected to remain consistent throughout the duration of the project.

3.2.6.3 This will be the location that all function and source checks will be performed at the beginning of the work day and the end of the work day for the duration of the project.

3.2.7 With the detector placed in the fixed geometry position with no radioactive check source present, perform 1-minute scaler count and record the background count rate on the Function Check Form. Unless directed otherwise by the Project Manager, repeat until ten background readings are recorded.

3.2.8 Repeat the 1-minute scaler counts with the radioactive check source in place. Record the results on the Function Check Form. Unless directed otherwise by the Project Manager, repeat until ten background readings are recorded.

3.2.9 With Project Managers assistance determine the acceptable daily function check range. Typically this range will be the average of the initial ten counts plus or minus ten percent.

3.3 Daily Function Check.

3.3.1 The daily function check is typically performed twice daily, once before work activities have commenced and a second time when work activities have been completed. Follow steps 3.3.3 – 3.3.6 below for each time a function check is performed. If equipment is used for only a brief period of time, less than 1 hour, then a single daily pre-operations function check may be necessary.

3.3.2 Create a Daily Function Check form for each piece of equipment being used as described in 3.2.2 above. In the comments field note that the form is being used as a daily function check form.

3.3.3 Follow steps 3.2.3 – 3.2.5 above.

3.3.4 Measure the background count for one minute (unless otherwise directed by project manager) at the previously identified function check location (see 3.2.6 above). Record on the Daily Function Check form.

3.3.5 Repeat 3.3.4 with the check source in place. If the detector is dual channel (alpha/beta) then repeat again with the second source in place.

3.3.6 If the daily function check results do not fall within the acceptable daily function check range, as discussed in Section 3.2.9 above, check the source, geometry and immediate area to determine if anything may have caused the check to fail. If a reason is found attempt to fix the problem. Count again. If the daily function check results in a second failure remove the instrument from service and report the event to the Project Manager.

4. TRAINING

4.1 Prior to performance of calibrations or use in the field, all personnel must show proficiency in the operation of the detectors and meters being utilized.

4.2 Prior to use in the field, all personnel must show proficiency in use of the function check forms.

4.3 Prior to personnel being assigned to the field, supervisor must sign off of the Training Qualifications Form that he/she met requirements 4.1-4.2 above.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.3)

5.2 Computer generated files will be saved as hard copies and stored with instrument folders and/or project files.

6. REFERENCES

6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 4.03

Form 4.00 Training Qualification Form

7. ATTACHMENTS

7.1 Form 1.30A – Function Check Form (Single Channel)

7.2 Form 1.30B – Function Check Form (Dual Channel)

Author's Signature:	**Reviewed By:**
Charles P. Farr	Kenneth R Baker

STANDARD OPERATING PROCEDURE 2.08
MONITORING FOR RADIUM-226 IN SURFACE SOILS USING A GAMMA SCINTILLATION DETECTOR

1. PURPOSE

This procedure covers the use of gamma scintillation detectors for monitoring Ra-226 concentrations in soil. The soil concentrations are assessed by measuring the gamma exposure rates or gamma count rates and comparing them to previously determined gamma action levels. These action levels were derived from correlation studies completed earlier.

2. DISCUSSION

Monitoring of surface soils for Ra-226 is done for two purposes. Excavation control monitoring is done to determine if the readings are sufficiently low to assure that the area meets applicable cleanup criteria. The measurements are more informal and are normally not documented. Monitoring for verification is a more formal process where the grid block locations and gamma readings are formally documented.

3. PROCEDURE

3.1 Equipment

3.1.1 Ratemeter/Scaler.

3.1.2 Detector.

3.1.3 Collimator (if specified).

3.1.4 Check Source

3.1.5 Field notebook or appropriate forms.

3.2 Excavation Control Monitoring Using a Ludlum Model 19

The Ludlum Model 19 may be used to assess the approximate Ra-226 concentration in windblown contaminated soils. The gamma action levels are determined during calibration studies for the site and are provided in the Soil Cleanup Verification Survey and Sampling Plan, or equivalent. Care must be taken to assure that the conditions are the same as those that existed during the calibration studies.

3.2.1 The Model 19 should preferably be the same instrument as that used in the calibration studies. In any case, the instrument should have been calibrated at the same calibration facility using the same calibration source.

3.2.2 The instrument should be used in areas free of significant gamma shine from the tailings pile or other external sources.

3.2.3 The instrument should be held at approximately 1 meter height (waist level).

3.2.4 The meter reading should be observed over a period of time to obtain the average reading. When using the "fast response" mode, a five second observation period is normally adequate; when using the "slow response" mode, a 20 second observation period is normally required to obtain a good estimate of the average reading. The average reading should be compared to the action level.

3.2.5 When determining whether a grid block is likely to meet the cleanup criteria, use the fast response setting and slowly walk over the entire area, looking for areas that greatly exceed the average value. You may wish to mark these areas for further cleanup provided they are above the action level. After further cleanup, repeat the measurements until you are satisfied that the area has a high probability of meeting the standards.

3.3 Excavation Control Monitoring Using a Ludlum Model 2210/44-10

The Ludlum Model 2221/Ludlum 44-10 combination may be used to assess the approximate Ra-226 concentration in windblown contaminated soils. The gamma action levels were determined during calibration studies for the site for this combination of scaler/detector and are provided in the Soil Cleanup Verification Survey and Sampling Plan for the site, or equivalent. Care must be taken to assure that the conditions are the same as those that existed during the calibration studies. Since detectors vary in efficiency, it is best to use the same detectors that were used in the calibration studies. Assure that the high voltage, input sensitivity, cable type and length, and all other parameters are the same as those used in the calibration studies. Compare the function check results to those obtained during the calibration studies.

If the equipment used in the calibration studies is not available, the detector/scaler used must be evaluated to determine whether it can be adjusted to match the values used in the calibration studies. The same check source should be used at the identical location in the same geometry configuration as was use in the function check for the calibration studies. If adjustments cannot be made so that the detector responses agree for both

background count rate and source count rate conditions, other detectors should be evaluated until a match is found.

3.3.1 The instrument should be used in areas free of significant gamma shine from the tailings pile or other external sources. For gamma shine areas or for working in ditches or near embankments, the results using the lead shield will be more accurate than for the bare detector. However, remember that it is easier to miss contaminated areas when using the collimated shielded detector.

3.3.2 The instrument should be held at approximately 18 inches above the ground, if bare, and approximately 6 inches above the ground if in the lead collimating shield that was used in the calibration studies.

3.3.3 The meter reading should be observed over a period of time to obtain the average reading. When using the "fast response" mode, a five second observation period is normally adequate; when using the "slow response" mode, a 20 second observation period is normally required to obtain a good estimate of the average reading. The average reading should be compared to the action level.

3.3.4 When determining whether a grid block is likely to meet the cleanup criteria, use the fast response setting and slowly walk over the entire area, looking for areas that greatly exceed the average value. Mark these areas for further cleanup provided they are above the action level. After further cleanup, repeat the measurements until you are satisfied that the area has a high probability of meeting the standards.

3.3.5 For a more accurate and precise measurement, set the Ludlum 2221 switch to scaler mode and walk over the area for one minute while taking an integrated count. Compare this value to the action level for that detector.

3.4 Soil Cleanup Verification Using the Ludlum 2221/Ludlum 44-10 detectors

The calibration studies were done to support the use of these instruments to verify that the cleanup criteria are met. A land survey team should be employed to establish a 100 square meter grid (or approximately equivalent) across the area of interest. The site grid block nomenclature should be followed.

Follow steps in Section 3.3, paying special attention to assuring that the instruments are working the same as they did in the calibration studies. This should be carefully documented. If the same instruments are not available, the data to support equivalency should be carefully documented and approved by the designated manager prior to use.

While walking the grid block for the one-minute integrated count, develop a walking pattern and speed so that complete and uniform coverage is attained. This may require some effort and practice. Normally a brisk walking of lines 3-4 feet apart will result in near-complete coverage.

Document the results for each grid block by recording the Grid Block Number and the integrated one-minute count.

4. TRAINING

4.1 Prior to use in the field, all personnel must show an understanding of radiological posting requirements.

4.2 Prior to personnel being assigned to the field, supervisor must sign off of the Training Qualifications Form that he/she met requirements 4.1 above.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.3)

5.2 Computer generated files will be saved as print and electronic files and stored with field notebooks.

6. REFERENCES

6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 4.3

Form 4.00 Training Qualification Form

7. ATTACHMENTS

None.

Author's Signature:	**Reviewed By:**
Charles P. Farr	Kenneth R Baker

STANDARD OPERATING PROCEDURE 2.09
GAMMA-RADIATION CORRELLATION STUDIES

1. PURPOSE

This procedure outlines the procedures for creating a correlation between gamma-radiation surveys and either the exposure rate or radium-226 (Ra-226) concentrations in the soil.

2. DISCUSSION

This procedure provides information on creating correlations from surveys performed with ERG GPS-based gamma-radiation survey systems. The data from the gamma-radiation surveys is correlated to exposure rate measured by either a pressurized ion chamber (PIC), Ludlum Model 19, or similar instrument. The gamma-radiation may also be correlated to the Ra-226 soil concentration. This procedure assumes that gamma-radiation survey has already been performed.

Regardless of what correlation is being done, the method is similar. A GPS-based gamma-radiation survey is performed. Points representing the range of values of the survey are selected. At these locations measurements are made (i.e., exposure rates measured by PIC). An XY plot of the data can then be created and a linear regression performed to create an equation correlating gamma-radiation values to the measurement in question.

3. PROCEDURE

3.1 Equipment

3.1.1 Ratemeter/Scaler.

3.1.2 Detector.

3.1.3 Collimator (if specified).

3.1.4 Field notebook or appropriate forms.

3.1.5 Indelible ink pen.

3.1.6 Necessary equipment for making correlation measurements.

3.1.7 Soil sampling equipement if necessary.

3.1.8 Post-hole digger or other tools capable of obtaining 6-inch deep soil sample.

3.2 Data Collection

3.2.1 Point Studies

3.2.1.1 Using gamma radiation survey data, locate study areas that represent the range of values present. Five or more readings are usually sufficient. Areas should not

be in shine areas and should be on relatively flat terrain. Each study area should be large enough that a few steps in any direction should not affect the reading. Record the data for each location on ERG Form 2.09A or field notebook.

3.2.1.2 At each area, make a measurement using the specified equipment. Refer to the SOPs pertinent to the equipment being using for more information.

3.2.1.3 Using the same gamma detector and ratemeter/scaler used during the gamma-radiation survey, make a series of integrated counts in the immediate vicinity of the sample location. These values should be recorded on Form 2.09A, field logbook, or equivalent.

3.2.1.4 Repeat steps 3.2.1.1 through 3.2.1.3 for each location.

3.3 Linear Regression

3.3.1 In Microsoft Excel or other appropriate program, enter the data collected above.

3.3.2 Plot the data in an XY scatter plot.

3.3.3 Add a trend line and equation to the plot.

3.3.3.1 This equation is the linear regression and can be used to predict values over the range of gamma-radiation counts found during a survey.

4. TRAINING

4.1 Prior to use in the field, all personnel must show proficiency in the operation of the gamma-radiation survey equipment.

4.2 Prior to use in the field, all personnel must show proficiency in the use of Microsoft Excel or other equivalent program to create scatter plots and trend lines.

4.3 Prior to personnel being assigned to the field, supervisor must sign off of the Training Qualifications Form that he/she met requirements 4.1-4.2 above.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.03)

5.2 Computer generated files will be saved as print and electronic files and stored with field notebooks.

6. REFERENCES

6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 4.03

Form 4.00 Training Qualification Form

7. ATTACHMENTS

7.1 Form 2.09A

Author's Signature:	Reviewed By:
	Kenneth R Baker

STANDARD OPERATING PROCEDURE 2.15
SAMPLE CONTROL & DOCUMENTATION

1. PURPOSE

To define the steps necessary for sample control and identification, data recording and chain-of-custody documentation.

2. DISCUSSION

This procedure describes the typical method for sample control and documentation at a work site. Sample control and documentation are necessary to maintain an organized sample inventory for analysis and Quality Assurance. Documents typically used for sample control include but are not limited to: log books, sample logs, sample labeling , chain-of-custody forms, and analytical records.

3. PROCEDURE

3.1 Equipment

3.1.1 Sample Logs.

3.1.2 Logbooks.

3.2 Sample Labeling

3.2.1 Typically, samples collected at a work site include soil and air samples. If the client does not have a standard nomenclature system for naming samples, then a sequential system should be developed which includes groups of letters and numbers identifying the type of sample as well as relating it to the project or site name.

3.2.2 Use soil and air sample labeling on containers to identify the sample. Soil samples are typically collected in plastic re-sealable bags and should be uniquely identified with a permanent marker. Collected air samples can be placed into coin envelopes which have been pre-stamped with the date, time on and time off, sample number, air sampler serial number, beginning and ending flow rates and vacuum reading if applicable.

3.2.3 A logbook may be used to record pertinent information regarding the sample. For specific information regarding the use of the logbook, refer to SOP 4.07. Information put in logbook might include collection method, sampling crew, location (GPS or descriptive).

3.3 Chain-of-Custody

3.3.1 The primary purpose of the Chain-of-Custody is to create a written record that can be used to trace the possession and handling of the sample collected.

3.3.2 To transfer custody of a sample, a Custody Transfer Record (Form 3.02A) or equivalent analytical laboratory form can be used. The appropriate sections must be filled out to instruct the laboratory to perform the analysis required for the samples collected. The transferee must sign and record the date and time to relinquish custody of the samples to the analytical laboratory.

3.3.3 Send all packages to the laboratory with the Chain-of-Custody record. Retain a copy of these forms at the site office.

4. TRAINING

4.1 Prior to use in the field, all personnel must show proficiency in the operation of the beta scintillation detectors.

4.2 Prior to use in the field, all personnel must show proficiency in use of the calibration forms

4.3 Prior to use in the field, all personnel must show proficiency in and understanding of the Plateau Curve.

4.4 Prior to personnel being assigned to the field, supervisor must sign off of the Training Qualifications Form that he/she met requirements 4.1-4.3 above.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.3)

5.2 Computer generated files will be saved as print and electronic files and stored with field notebooks.

6. REFERENCES

6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 4.3

SOP 4.07

Form 4.00 Training Qualification Form

7. ATTACHMENTS

7.1 Form 3.02A – Custody Transfer Record/Lab Work Request Form

Author's Signature:	Reviewed By:
Charles P. Farr	Kenneth R Baker

STANDARD OPERATING PROCEDURE 2.22
SURFACE AND SHALLOW SUBSURFACE SOIL SAMPLING

1. PURPOSE

This procedure outlines the appropriate equipment and materials, methods, and recordkeeping requirements for collecting surface and shallow subsurface soil samples from project locations.

2. DISCUSSION

Soil samples are used to assess the distribution and intensity of constituent of concern for a wide variety of applications ranging from characterization of undisturbed areas to verification that remedial activity goals have been attained. Soil samples may be collected at systematic locations on a routine frequency or they may be collected at discrete or random locations to assess the impacts of unplanned releases, spills, or other contamination events. The analytical requirements placed on soil samples depend on the type and proximity to the project area and the desired reporting radiological, chemical, and geochemical characteristics. This information is typically described in the project sampling plan.

Surface soil samples are defined as samples coming from an interval of ground surface to a depth of 15 cm below ground surface (BGS). Shallow subsurface samples are defined as samples coming from an interval ranging from 15cm BGS to 1.5 m BGS, in which hand sampling methods are adequate to sample the desired interval. Samples taken below 5 ft BGS typically require mechanized methods of collection including motorized augers and drill rigs..

3. PROCEDURE

3.1 Soil Sampling Process

3.1.1 Identify sample locations using work plan maps or work instructions with GPS equipment. Mark locations with pin flags or equivalent if soil sample is not to be collected immediately to prevent having to re-navigate back to the point.

3.1.2 Clear debris, loose brush, and vegetation from sample locations.

3.1.3 Collect the soil sample using shovel and trowel methods for surface soil samples and hand augers or equivalent for shallow subsurface soil sample collection. Samples should be collected in a heavy duty Ziplock plastic bag or equivalent.

3.1.4 Collect auger cuttings for the desired depth by measuring the depth of the auger bit. For example, cuttings from an auger penetration interval of 24 to 30 inches are

appropriate for required a sample of that depth. If used, drive sampling tubes to the desired depth and extract by hand or hand jack. Cap the end of the sample tube upon removal.

3.1.5 Add preservatives or otherwise prepare containers according to special instructions from the project manager or as described in the work plan. Document the sample ID, depth, preservation method, location, and other important sample descriptions

3.1.6 Collect quality control samples as directed in the work plan or project manager.

3.1.7 If using sampling equipment for multiple locations, wash surfaces of the tools with deionized water and dry prior to use at another sample location. Release rinse water to the ground unless the work plan or project manager designates that it be retained.

3.1.8 Fill out laboratory provided or ERG chain of custody (COC). Once all samples are collected, seal transport container with COC seals and prepare transport container for courier pick up.

3.1.9 All samples obtained will be sent to the analytical laboratory designated by the work plan or project manager.

4. TRAINING

4.1 Prior to use in the field, all personnel must demonstrate an understanding of the soil sampling process.

4.2 Prior to personnel being assigned to the field, supervisor must sign off of the Training Qualifications Form that he/she met requirements 4.1 above.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.3)

5.2 Computer generated files will be saved as print and electronic files and stored with field notebooks.

6. REFERENCES

6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 4.3

Form 4.00 Training Qualification Form

7. ATTACHMENTS

None.

Author's Signature:	Reviewed By:
Charles P. Farr	Kenneth R Baker

STANDARD OPERATING PROCEDURE 4.10
TECHNICAL QUALITY CONTROL

1. PURPOSE

To describe the quality control program for conducting site activities employing ERG Standard Operating Procedures

2. DISCUSSION

This procedure applies to all site personnel employed by ERG or subcontractor employees. This procedure applies to all tasks designated in the QA/QC Plan. At a minimum, all measurements related to health and safety, contamination control, and final verification measurements will be done following this procedure.

3. PROCEDURE

3.1 Personnel Training and Management

3.1.1 It is the Corporation's responsibility to assure that a site manager or team leader is chosen who has the proper training and talents to manage all operations anticipated at the site. In addition, it is the team leader's responsibility to assure that all personnel are properly trained and suited to perform the duties expected of them..

3.1.2 The team leader must identify all tasks associated with a project and assure that ERG Standard Operating Procedures are appropriate and applicable. A Training Qualification Form must be developed for documentation of training for each technician. An example of this form is attached.

3.1.3 For each task that a technician performs, the technicians must review the procedure and demonstrate that they can perform the task satisfactorily. For difficult tasks or for junior technicians, a period of time may be required when the technician works with a qualified technician before being officially qualified to perform the tasks. At that time, the team leader will sign the Training Qualification Form for that task. It is everyone's responsibility to assure that tasks are only performed by qualified staff.

3.1.4 It is the team leader's responsibility to periodically provide training and to monitor the performance of tasks

3.2 Performing Tasks

3.2.1 The ERG Standard Operating Procedures must be readily available to all personnel. Data forms specified in the procedures will be placed in a central location and appropriately labeled.

3.2.2 All data must be recorded on the appropriate form using a black waterproof pen. Any changes must be made by a single line through the entry and initialed and dated by the technician. If it is necessary to recopy the entire form, the old form must be properly noted and attached.

3.2.3 All technicians are responsible for assuring that the instrumentation used is calibrated, function checked, and otherwise working properly before making a measurement.

3.2.4 All technicians are responsible for reviewing all paperwork prior to submitting to the authorized individual. In particular, all paperwork must be completed, dated, and signed by the technician(s) prior to submittal.

3.3 Quality Reviews

3.3.1 All data forms must be reviewed by the team leader or his/her designee within 24 hours of data collection

3.4 Quality Audits

3.4.1 For projects lasting more than six months, an annual Quality Audit must be conducted to assure that this procedure is being followed

3.5 Records

3.5.1 Records of the completed work, measurements and data must be preserved, protected and retained according to the contract and/or ERG's record retention process (see SOP 4.03)

4. TRAINING

Not Applicable.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.3)

5.2 Computer generated files will be saved as print and electronic files and stored with field notebooks.

6. REFERENCES

6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 4.03

Form 4.00 Training Qualification Form

7. ATTACHMENTS

7.1 4.00 Training Qualification Form

Author's Signature:	**Reviewed By:**
Charles P. Farr	Kenneth R Baker

STANDARD OPERATING PROCEDURE 4.12
SOIL DATA VALIDATION

1. PURPOSE

The purpose of this procedure is to define criteria for assessing soil sample data quality. This procedure addresses data validation for radionuclides and inorganic analytical laboratory results for soil samples and assignment of data qualifiers. The data validation process includes an evaluation of raw analytical laboratory data to assess the quality of results. Data validation may also include evaluation of field data, holding times, chain-of-custody forms, instrument detection limits, calibration and internal standards, laboratory blanks, laboratory control standards, laboratory duplicate analyses, field duplicate analyses, matrix spike sample analyses, intermethod comparisons, interference sample analyses, duplicate injection and post digestion spike analyses, serial dilution analyses, and data completeness.

2. DISCUSSION

This procedure supports the ERG QA Plan.

The level of validation for the soil data is based on the intended use of the data, as determined on a project-by-project basis.

3. DEFINITIONS

Data validation - a process that applies performance-based criteria to data that may result in qualification of the data. The process is performed independently from the data generator, before conclusions are drawn from the data. In this procedure, the term also includes evaluations of the completeness, correctness, consistency of the data, and proper conformity.

Field parameters - In this procedure, field parameters that require validation are related to completeness of documentation; e.g., proper identification of soil sample locations on soil sample logs and verification of signatures and dates on the chain-of-custody (COC).

Laboratory Control Standard (LCS) - any Quality Assurance/Quality Control (QA/QC), reference, or control sample that is included in the daily analysis to assess the accuracy of the result.

Laboratory QC Report - the portion of the laboratory report that addresses QC criteria, consisting of laboratory blank, LCS percent recovery, relative percent differences in laboratory duplicates, and spike recovery.

Holding time - the time between sample collection and analysis. Each analytical method establishes a holding time to ensure that samples are not affected by analyte degradation.

Method Detection Limit (MDL) - the minimum concentration of a substance that can be distinguished from the absence of that substance (a blank value) within a stated confidence limit. The method detection limit is equivalent to the lower limit of detection (LLD) and the instrument detection limit (IDL) in this procedure.

Precision - A measure of agreement of individual results of a constituent in the same sample.

Quality Control (QC) criteria - in this procedure, QC criteria may include preservation, holding time, blanks, duplicates, COC completion, project-specified MDLs, laboratory calibrations, LCS recoveries, and matrix spike recoveries.

4. PROCEDURE

Table 1 lists the criteria considered during data validation and the associated section in which they are discussed.

If preliminary validation of the data has been performed for other requirements (e.g., invoice approval), then the validator may use its results to fulfill the requirements of this procedure.

Table 1
Criteria Considered During Data Validation

Data Evaluation Elements	Procedure Section
Field Data Validation	4.1
Holding Time	4.2
Chain-of-Custody	4.3
Method Detection Limits	4.4
Calibration and Internal Standards	4.5
Laboratory Blanks	4.6
Laboratory Control Standards	4.4
Laboratory Duplicate Sample Analyses	4.8
Field Duplicate Sample Analyses	4.9
Matrix Spike Samples	4.10
Furnace Atomic Absorption QC Analyses	4.11
ICP-MS Serial Dilution Analysis	4.12
Inter-method Comparisons	4.13
Data Completeness	4.14
Sample Results Verification	4.15

4.1 Field Data Validation

4.1.1 Objective - The objective for review of select field data is to determine if the soil samples were collected and the effort documented properly for preliminary evaluation of the analytical results. Field data validation will consist of verification of the field log-book and sampling documents.

4.1.2 Criteria - Records will be reviewed to identify transcription errors and ensure that adequate documentation was attained.

4.1.3 Evaluation Procedure - The validator will verify that the sample locations are recorded on a scaled map or identified by geopositions. The validator will also evaluate field notes to verify that the conditions, equipment, samples, procedures, and samplers were recorded. Field notes will include sample identification, location, type, date and time of collection, sample depth, and associated observations. The validator will review the field notes and verify that information is consistent with the COC and the laboratory report.

4.1.4 Action - Discrepancies will be investigated. Discrepancies that cannot be resolved may require the validator to qualify the data based on professional judgment.

4.2 Holding Times

4.2.1 Objective - The objective is to assess the quality of the results based on the holding time defined by the method from time of sample collection to analysis.

4.2.2 Criteria - Calculate the holding time from the COC and laboratory records as follows:

Analyte Holding Time (days) = Analysis Date - Sampling Date

4.2.3 Evaluation Procedure - The validator will verify that the sample locations are recorded on a scaled map or identified by geopositions. The validator will also evaluate field notes to verify that the conditions, equipment, samples, procedures, and samplers were recorded. Field notes will include sample identification, location, type, date and time of collection, sample depth, and associated observations. The validator will review the field notes and verify that information is consistent with the COC and the laboratory report.

4.2.4 Action - If a criterion for the holding time was not met, qualify all results greater than the MDL as estimated (J) and results less than the MDL as non-detected, estimated (UJ).

4.3 Chain-of-Custody Forms

4.3.1 Objective - The objective is to evaluate the COC forms to determine that the appropriate information was entered and sample control maintained. The COC form provides a record of possession and handling of a soil sample from the point of collection through laboratory receipt. A sample is considered to be in someone's custody if it is in their actual physical possession, within their view, sealed in a closed container, or kept in a secure area that is restricted to site personnel. When possession of the samples is transferred, the transferee will sign and record the date and time on the COC, which will accompany the sealed containers. Each person -- within a particular organization and location-- who takes custody of the samples is required to fill in the appropriate section on the COC.

4.3.2 Criteria - Records will be compared to identify transcription errors and to verify that sample transfer was adequately documented.

4.3.3 Evaluation Procedure - The validator will verify that the COC has been completed properly. Verification will consist of confirmation of: 1) project name, laboratory of destination, sampler's name and affiliation, site, sample identifier, date sampled, analytical parameters, number of containers, delivery method, signature, and date relinquished; and 2) samples received in good condition with legible labels and properly logged in by the laboratory. In addition, it will be verified that the analytes requested on the COC match those listed in the laboratory report. Samples that have been received in unacceptable condition may require re-sampling.

4.3.4 Action - Discrepancies between the COC, parameter list or the laboratory report will be clarified before further validation. Discrepancies that cannot be resolved may require the validator to qualify the data based on professional judgment. The validator will document all such discrepancies and, as applicable, justification for qualifying the data.

4.4 Method Detection Limits

4.4.1 Objective - The objective is to evaluate data quality by comparing the MDLs reported by the laboratory with those specified in the associated work plan.

4.4.2 Criteria - MDLs are specified in the associated work plan.

4.4.3 Evaluation Procedure - The validator will compare the MDLs associated with results in laboratory reports to the MDLs specified in the associated work plan.

4.4.4 Action - If the MDL has been exceeded for an analyte that has not been detected in the sample, the data may be qualified as J. If the analyte is reported above detection levels, laboratory-reported MDLs greater than work plan-specified MDLs are acceptable.

4.5 Calibration and Internal Standards

4.5.1 Objective - Requirements for instrument calibration are established to verify that the instrument is capable of producing acceptable quantitative data. Initial calibration verification (ICV) demonstrates that the instrument is capable of acceptable performance at the beginning of the analysis run, and continuing calibration verification (CCV) documents that the initial calibration is still valid.

4.5.2 Criteria

Initial Calibration

Instruments must be calibrated daily and each time the instrument is set up.

a. Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS) Analysis

A blank and at least one standard must be used in establishing the analytical curve.

b. Atomic Absorption Analysis

A blank and at least three standards, one standard must be at the Contract Required Detection Limit (CRDL) used in establishing the analytical curve. The correlation coefficient must be greater than or equal to 0.995.

c. Fluorimetric Analysis

A blank and three standards must be used in the calibration.

d. Alpha Spectroscopy Analysis

Calibration frequency is governed by daily performance check results for each instrument detector. Control charts are maintained of the daily performance check standard and instrument control for each detector must be within 3σ error. A daily background check is also performed and must be within 3σ error.

e. Gamma Spectroscopy Analysis

Calibration frequency is governed by daily performance check results for each instrument detector. Control charts are maintained of the daily performance check standard and instrument control for each detector must be within 3σ error. A daily background check is also performed and must be within 3σ error.

Continuing Calibration Verification

a. ICP-MS Analysis

Results must fall within the control limits specified in the associated work plan. The frequency of the continuing calibration must meet contract specified critieria.

b. Atomic Absorption Analysis

Results must fall within the control limits specified in the project specific sampling plan. The frequency of the continuing calibration must meet contract-specified critieria.

c. Fluorimetric Analysis

Results must fall within the control limits specified in the associated work plan. The frequency of the continuing calibration must meet contract-specified critieria.

d. Alpha Spectroscopy Analysis

Results must fall within the control limits specified in the associated work plan.

e. Gamma Spectroscopy Analysis

Results must fall within the control limits specified in the associated work plan.

4.5.3 Evaluation Procedure

a. ICP-MS Analysis

1. Verify that the instrument was calibrated daily and for each setup using the correct number of standards and blanks.
2. Where the number of calibration standards used is greater than or equal to 3, verify that the correlation coefficient is greater than or equal to 0.995. Where the number of calibration standards used is less than 3, analysis of the check standard and calibration verification must yield recoveries of 90 - 100%. Replicate integrations (minimum of two), when reported, must yield a relative standard deviation (RSD) less than 5%.
3. Recalculate one or more of the ICV and CCV %R using the following equation and verify that the recalculated value agrees with the laboratory reported value.

$$\%R = \frac{Found}{True} \; x \; 100$$

where,

Found is the concentration of each analyte measured in the analysis of the ICV or CCV
True is the concentration of each analyte in the ICV or CCV standard

Because of possible rounding discrepancies, allow results to fall within 1 percent of the specific range.

b. Atomic Absorption Analysis

1. Verify that the instrument was calibrated daily and each time the instrument was set up using the correct number of standards and blanks.
2. Verify that the correlation coefficient is greater than or equal to 0.995
3. Recalculate one or more of the ICV and CCV %R using the following equation and verify that the recalculated value agrees with the laboratory reported values.

$$\%R = \frac{Found}{True} \; x \; 100$$

where,

Found is the concentration of each analyte measured in the analysis of the ICV or CCV

True is the concentration of each analyte in the ICV or CCV standard

Because of possible rounding discrepancies, allow results to fall within 1 percent of the specific range.

c. Fluorimetric Analysis

1. Verify that the instrument was calibrated daily and each time the instrument was set up using the correct number of standards and blanks.
2. Verify that the correlation coefficient is greater than or equal to 0.995

3. Recalculate one or more of the ICV and CCV %R using the following equation and verify that the recalculated value agrees with the laboratory reported values.

$$\%R = \frac{Found}{True} \; x \; 100$$

where,

Found is the concentration of each analyte measured in the analysis of the ICV or CCV

True is the concentration of each analyte in the ICV or CCV standard

Because of possible rounding discrepancies, allow results to fall within 1 percent of the specific range.

d. *Alpha Spectroscopy Analysis*

1. Verify that a daily performance check was completed for each detector.
2. Verify that the daily performance check was within the 3 σ error term on the control chart.
3. If the daily performance check was not within the 3 σ error term, then check that two additional counts were performed that were within the 2 σ error term for that day.
4. Verify that a daily background check was completed for each detector.
5. Verify that the daily background check was within the 3 σ error term on the control charts.
6. If the daily background check was not within the 3 σ error term, then check that two additional counts were performed that were within the 2 σ error term for that day.

e. *Gamma Spectroscopy Analysis*

1. Verify that a daily performance check was completed for each detector.
2. Verify that the daily performance check was within the 3 σ error term on the control chart.

3. If the daily performance check was not within the 3 σ error term, then check that two additional counts were performed that were within the 2 σ error term for that day.
4. Verify that a daily background check was completed for each detector.
5. Verify that the daily background check was within the 3 σ error term on the control charts.
6. If the daily background check was not within the 3 σ error term, then check that two additional counts were performed that were within the 2 σ error term for that day.

4.5.4 Action

a. *ICP-MS Analysis*

1. If the minimum number of standards were not used for initial calibration, or if the instrument was not calibrated daily and each time the instrument was set up, qualify the data as unusable, R.
2. If the number of standards used is ≥ 3, and the calibration correlation coefficient is < 0.995, qualify results > IDL as J, and results < IDL as UJ. If the number of standards used is < 3, and the associated recoveries are < 90% or > 100%, or the RSD of a minimum of two replicate integrations is ≥ 5%, qualify results >IDL as estimated (J), and results < IDL as UJ.
3. If the ICV or CCV %R falls outside the acceptance windows, use professional judgment to qualify associated data. If possible, indicate the bias in the review.
4. If the frequency of the CCV does not meet contract specifications, qualify all associated data as J.

d. Atomic Absorption Analysis

1. If the minimum number of standards were not used for initial calibration, or if the instrument was not calibrated daily and each time the instrument was set up, qualify the data as unusable, R.

2. If the correlation coefficient is less than 0.995, qualify results greater than the MDL as estimated (J), and results less than the MDL as estimated (UJ).
3. If the ICV or CCV percent recovery (%R) falls outside the acceptance windows, use professional judgment to qualify associated data. If possible, indicate the bias in the review.
4. If the frequency of the CCV does not met contract specifications, qualify all associated data as estimated (J).

c. *Fluorimetric Analysis*

1. If the minimum number of standards were not used for initial calibration, or if the instrument was not calibrated daily and each time the instrument was set up, qualify the data as unusable, R.
2. If the correlation coefficient is less than 0.995, qualify results greater than the MDL as estimated (J), and results less than the MDL as estimated (UJ).
3. If the ICV or CCV percent recovery (%R) falls outside the acceptance windows, use professional judgment to qualify associated data. If possible, indicate the bias in the review.
4. If the frequency of the CCV does not met contract specifications, qualify all associated data as estimated (J).

d. *Alpha Spectroscopy Analysis*

1. If a daily performance check was not conducted for the detector, or if the daily performance check was outside the 3σ error term on the control chart and two additional counts for that day were not within the 2 σ error term, qualify the data as R.
2. If a daily background check was not conducted for the detector, or if the daily background check was outside the 3σ error term on the control chart and two additional counts for that day were not within the 2 σ error term, qualify the data as R.

e. *Gamma Spectroscopy Analysis*

1. If a daily performance check was not conducted for the detector, or if the daily performance check was outside the 3σ error term on the control chart and two additional counts for that day were not within the 2 σ error term, qualify the data as R.
2. If a daily background check was not conducted for the detector, or if the daily background check was outside the 3σ error term on the control chart and two additional counts for that day were not within the 2 σ error term, qualify the data as R.

4.6 Laboratory Blanks

4.6.1 Objective - The objective of assessing laboratory blank results is to determine the existence and magnitude of analytical laboratory contamination. The criteria for evaluation of blanks apply to any blank associated with the samples. If problems with blanks exist, all data associated with the blank results must be carefully evaluated to determine whether or not there is an inherent bias in the data, or if the problem is an isolated occurrence.

4.6.2 Criteria - No contaminants should be in the calibration blank(s) and the number of calibration blanks reported in a data package should be at least 10% of the total number of samples reported. Preparation blanks should not exhibit contaminant concentrations > MDL and the number of preparation blanks reported in a data package should be at least 5% of the total number of samples reported.

4.6.3 Evaluation Procedure - Review the results for the blank(s) and verify that there were no laboratory contaminants detected and that the appropriate frequency of blanks was reported.

4.6.4 Action

1. Action in the case of detection of contaminants in the blank sample depends on the circumstances and origin of the blank. Professional judgment is required for the quality assessment of blank results.

Results greater than the MDL but less than 5 times the amount in any calibration blank should be qualified as U.

Note: The blank analyses may not involve the same weights, volumes, or dilution factors as the associated samples. The validator may find it easier to work from the raw data when applying 5 times criteria to soil sample data/calibration blank data. In instances where more than one blank is associated with a given sample, qualification should be based on a comparison with the associated blank having the highest concentration of a contaminant. The results should not be corrected by subtracting the blank value.

2. If the reported frequency of the calibration blanks when compared to reported samples is not greater than or equal to 10 percent, qualify the data as J.

   If the reported frequency of the preparation blanks when compared to reported samples is not ≥ 5%, qualify the data as J.

   If the reported preparation blank concentration is > MDL, all associated sample results < 10 times the preparation blank should be qualified with blank detection (B).

4.7 Laboratory Control Standard Analysis

4.7.1 Objective - The LCS analysis is designed to assess the efficiency of the digestion procedure.

4.7.2 Criteria - All LCS results must fall within the control limits specified in the project-specific sampling plan or the Contract Laboratory Technical Specifications.

4.7.3 Evaluation Procedure

1. Review the data and verify that the results fall within the control limits.
2. Check the raw data to verify the reported recoveries. Recalculate one or more of the %R using the following equation:

$$LCS\ \%R \quad = \quad \frac{LCS\ Found}{LCS\ True} \quad x \quad 100$$

where,

LCS Found is the concentration of each analyte measured in the analysis of the LCS

LCS True is the concentration of each analyte in the LCS standard

4.7.4 Action

1. If the LCS recovery for any analyte falls outside the control limits, qualify the sample results greater than the MDL as J.
2. If the LCS results are higher than the control limits and the sample results are less than the MDL, the data are acceptable.
3. If the LCS results are lower than the control limits, qualify all sample results less than the MDL as UJ.
4. If LCS frequencies are less than 5 percent of the total number of reported samples, qualify the associated data as J.

4.8 Laboratory Duplicate Sample Analyses

4.8.1 Objective - The objective is to assess the precision of the sample results. Evaluation of the laboratory duplicate sample results assesses the precision of the instrumentation and analytical methods.

4.8.2 Criteria - The Relative Percent Difference (RPD) for metals and uranium and the Replicate Error Ratio (RER) for radionuclides must be within the specified sampling plan control limits for sample values greater than 5 times the CRDL.

4.8.3 Evaluation Procedure

1. Review and verify that results fall within the specified control limits.

2. Check the raw data and recalculate one or more RPD and RER using the following equations:

$$RPD = \frac{|X_1 - X_2|}{(X_1 + X_2)/2} \; x\, 100$$

where,

RPD is the relative percent difference between duplicate results,
X_1 and X_2 are the results of duplicate analyses

$$RER = \frac{|S - R|}{\sqrt{TPU_s^{\,2} + TPU_R^{\,2}}}$$

where,

RER is the replicate error ratio
S is the sample value
TPU_s is the total propagated uncertainty for the sample
R is the duplicate value for the sample, and
TPU_R is the total propagated uncertainty for the replicate

4.8.4 Action - If duplicate analysis results for a particular analyte fall outside the appropriate control windows, qualify the results for that analyte in all samples associated with the duplicate analyses as J.

4.9 Field Duplicate Sample Analyses

4.9.1 Objective - Field duplicate samples may be taken and analyzed as an indication of overall precision. These analyses measure both field and laboratory precision; therefore, the results may have more variability than laboratory duplicates that measure only laboratory performance. It is also expected that soil duplicate results will have greater variance than those for samples obtained from other media, because of the relatively more heterogeneity in structure, composition, etc. of soils.

4.9.2 Criteria

1. The RPD for metals and uranium and the RER for radionuclides must be within the specified sampling plan control limits for sample values greater than 5 times the CRDL.
2. Field duplicate frequencies specified in project plans must be met.

4.9.3 Evaluation Procedure

1. Review and verify that results fall within the specified control limits.
2. Check the raw data and recalculate one or more RPD and RER using the following equations:

where,

RPD is the relative percent difference between duplicate results,
X_1 and X_2 are results of duplicate analyses

$$RER = \frac{|S - R|}{\sqrt{TPU_s^{\,2} + TPU_R^{\,2}}}$$

where,

RER is the replicate error ratio
S is the sample value
TPU_s is the total propagated uncertainty for the sample
R is the duplicate value for the sample, and
TPU_R is the total propagated uncertainty for the replicate

4.9.4 Action

1. If the field duplicate analysis results for a particular analyte fall outside the appropriate control windows, qualify the results for that analyte in all samples associated with the duplicate analyses as J.
2. If the frequency of field duplicates was not met, then use professional judgment to qualify the data. The validator should justify qualifiers assigned to the data based upon frequency criteria.

4.10 Matrix Spike Sample Analysis

4.10.1 Objective - The objective of assessing matrix spike sample analysis is to provide information about the effect of the sample matrix on the digestion and measurement methods.

4.10.2 Criteria - MDLs are specified in the associated work plan.

1. Spike recovery (%R) must be within the specified control limits. Note: Spike recovery limits do not apply when sample concentration exceeds the spike concentration by a factor of ≥4. In addition, spike recoveries are not performed for gamma spectroscopy analyses.
2. Matrix spike frequencies shall be greater than or equal to 5 percent of the total number of reported samples.

4.10.3 Evaluation Procedure

1. Review and verify that the results fall within the specified control limits.
2. Check raw data and recalculate one or more %R using the following equation to verify the reported results:

$$\%R = \frac{(SSR - SR)}{SA} x\ 100$$

where,

SSR is the spike sample result
SR is the sample result
SA is the spike added

3. If the resultant recovery is outside the control limits, new spike recovery control limits, considering the counting error for radionuclides at the 95 percent confidence level, are then calculated by:

$$\frac{SSR_{UL} - (SR + 1.96\sigma_{SR})}{SA}(100) = 125\%$$

and

$$\frac{SSR_{LL} - (SR - 1.96\sigma_{SR})}{SA}(100) = 75\%$$

By rearrangement:

$SSR_{UL} = 1.25\ (SA) + (SR + 1.96\ \square SR)$
$SSR_{LL} = 0.75\ (SA) + (SR - 1.96\ \square SR)$

where,

SSR_{UL} is the spiked sample result upper limit
SSR_{LL} is the spiked sample result lower limit
SA is the spike added
SR is the sample result
$1.96\sigma SR$ is the 1.96σ error of sample result.

4.10.4 Action

a. ICP, Fluorimetry, Radionuclides

1. If the spike recovery is greater than 125 percent and the reported sample results are less than the MDL, the data are acceptable.
2. If the spike recovery is greater than 125 percent or less than 75 percent and the reported sample levels are greater than the MDL, qualify the data for these samples as J, unless the 1.96σ is determined to be within control limits for radionuclides.
3. If the spike recovery falls within the range of 30-74 percent and the sample results are less than the MDL, qualify the data for these samples as UJ.
4. If spike recovery results fall less than 30 percent and the sample results are less than the MDL, qualify the data for these samples as R.
5. If the frequency of matrix spike samples is less than 5 percent of the total number of reported samples, qualify the associated data as J.

b. Furnace

1. If the furnace matrix spike recovery is less than 75 percent or greater than 125 percent, and the method of Standard Addition (MSA) is required and not performed, qualify the data for these samples as estimated (J).

2. If the furnace matrix spike recovery is less than 75 percent or greater than 125 percent, and the MSA, is not required, qualify the data for these samples as estimated (J).
3. If the frequency of matrix spike samples is less than 5 percent of the total number of reported samples, qualify the associated data as estimated (J).

4.11 Furnace Atomic Absorption QC Analysis

4.11.1 Objective - Furnace post-digestion spikes (also referred to as analytical spikes) assist in establishing the accuracy of the individual analytical measurements, and determine the need for the Method of Standard Additions (MSA).

4.11.2 Criteria - Post-digestion spike of a sample shall be injected immediately after that sample. The spike recovery (%R) must be within specified control limits. MSA must be performed, as required, the analyze additions must be at the appropriate concentration levels, and the MSA correlation coefficient must be ≥ 0.995.

4.11.3 Evaluation Procedure

1. Review and verify that post-digestion spikes have been performed as required and that recovery (%R) falls within control limits.
2. Check the raw date to verify that the MSA was conducted pursuant to requirements and that the correlation coefficient is ≥ 0.995.

4.11.4 Action

1. If the post digestion spike recovery is less than 85 percent or greater than 115 percent, analyze the sample by MSA.
2. If MSA is required but has not been done, qualify the data as estimated (J).
3. If any of the samples run by MSA have not been spiked at the appropriate levels, qualify the data as estimated (J).
4. If the MSA correlation coefficient is less than 0.995, qualify the data as estimated (J).

4.12 ICP Serial Dilution Analysis

4.12.1 Objective - The objective of assessing serial dilution analysis is to determine whether physical or chemical interferences exist due to sample matrix.

4.12.2 Criteria - If the analyte concentration is sufficiently high (concentration in the original sample is minimally a factor of 50 above the IDL), an analysis of a 5-fold dilution must agree within 10 percent difference (5%D) of the original results.

4.12.3 Evaluation Procedure

1. Check the raw data and recalculate the %D using the following equation to verify that the dilution analysis results agree with the reported results.

$$\%D = \frac{|I - S|}{I} x\ 100$$

where,

I is the initial sample result
S is the serial dilution result (instrument reading times 5)

2. Check the raw data for evidence of negative interference; e.g., results of the diluted sample are significantly higher than the original sample.

4.12.4 Action

1. When criteria are not met, qualify the associated data as J.
2. If evidence of negative interference is found, use professional judgment to qualify the data. The validator will document discrepancies and the justification for qualifying the data.

4.13 Assessment of Data Completeness

4.13.1 Objective - Completeness is a measure of the valid data obtained from the analytical measurement process as a comparison to the quantity of valid data planned for the project.

4.13.2 Criteria - The percentage of valid data (%C) must meet the criteria established in the project plans.

4.13.3 Evaluation Procedure

Calculate the percentage of valid data (%C) as follows:

$$\%C = \frac{V}{D} x\ 100$$

where,

%C is the percentage of valid data for each analytical parameter
V is the number of valid results for each analytical parameter
D is the number of samples submitted for analysis for each parameter

Note: With the exceptions of those assigned R qualifiers, all laboratory measurement results are valid.

4.13.4 Action - The validator must use professional judgment to determine the overall effect of the completeness of the data. The validator will provide discussion related to the overall completeness of the database for each project considered.

4.14 Sample Result Verification

4.14.1 Objective - The objective of sample result verification is to confirm the accuracy of reported results.

4.14.2 Criteria - Analyte quantitation must be calculated according to the associated work plan.

4.14.3 Evaluation Procedure

Examine approximately 5 percent of the raw data to verify the correct calculation of sample results reported by the laboratory. Compare digestion and distillation logs, instrument printouts, strip charts, etc. to the reported sample results.

1. Examine the raw data for anomalies; e.g., baseline shifts, negative absorbance, omissions, and legibility.

2. Verify that there are no transcription or reduction errors; e.g., dilutions, and sample weights.
3. Verify that results fall within the linear range for the ICP parameters and within the calibrated range for the non-ICP parameters.
4. Verify that sample results are greater than 5 times the ICP-MS MDL, if ICP-MS results are used for arsenic, thallium, selenium, or lead.

4.14.4 Action - If any discrepancies are found, the laboratory may be contacted by the PM or designated representative to obtain additional information that could resolve any differences. If a discrepancy remains unresolved, the validator may determine that qualification of the data is warranted.

5. OVERALL ASSESSMENT OF DATA FOR A CASE

It is appropriate for the data validator to make professional judgments and comments on the validity of the overall data for a case. This is particularly appropriate when several QC criteria used to assess validity are out of specification. The additive nature of QC criteria out of specification is difficult to assess in an objective manner, but must be done by the validator to inform the users of the quality and limitation of the data to avoid inappropriate use.

6. TRAINING

6.1 Not applicable.

7. RECORDS

7.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.3)

7.2 Computer generated files will be saved as print and electronic files and stored with field notebooks.

8. REFERENCES

8.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 4.3

9. ATTACHMENTS

Data Validation Worksheets.

Author's Signature:	Reviewed By:
Charles P. Farr	Kenneth R Baker

ATTACHMENT 1

Data Validation Worksheets
Validation for Remedial Verifications and Risk Assessments

Soil Data Validation

Site_____ Project _____

Lab Job No._____ Sample ID's_____

Sample Date_____

Laboratory_____

Validation Date_____ Type_____

Method:_____

Criteria	OK	FYI	Action	Comments
Holding Times				
Chain-of Custody				
Detection Limits				
Calibration Blanks				
Initial Calibration				
Continuing Calibration				
Blanks				
Lab Control Sample				
Lab Duplicate				
Matrix Spike				
Other Pertinent Criteria:				
Criteria	**OK**	**FYI**	**Action**	**Comments**

Additional Comments _____
_____
_____

Signature:_____ Date:_____

STANDARD OPERATING PROCEDURE 5.11
SETUP AND OPERATION OF TRIMBLE PRO XRS RECEIVER WITH TRIMBLE TSCE DATALOGGER

1. PURPOSE

The purpose of the procedure is to instruct the user on how to properly setup a Trimble Pro XRS GPS unit to perform real time GPS gamma surveys using a Trimble TSCe datalogger and Ludlum 2221 ratemeter/scaler with RS-232 data output.

2. DISCUSSION

This SOP discusses the integration of a Trimble Pro XRS GPS unit, a Trimble TSCe datalogger, and a Ludlum 2221 ratemeter/scaler with RS-232 data output for use in conducting GPS radiological surveys. A data record is "logged" every time the 2221 outputs a data value to the TSCe through its RS-232 output. The GPS calculates its location every one second. The coordinate associated with each data value is interpolated between the locations calculated in the second before and after each data value is received. The TSCe records each data value as a "Not-In-Feature" record and associates the interpolated coordinate with the record. It is important the TSCe settings are correct to ensure the integrated components work together correctly.

3. PROCEDURE

3.1 Equipment

3.1.1 Trimble Pro XRS or XR GPS receiver.

3.1.1.1 When real-time data correction (dGPS) is necessary, a Pro XRS receiver and XRS antenna is necessary. Otherwise, the XR may be used.

3.1.2 Trimble Pro XRS or XR antenna. (see 3.1.1.1)

3.1.3 Trimble TSCe datalogger with stylus.

3.1.4 Charged batteries

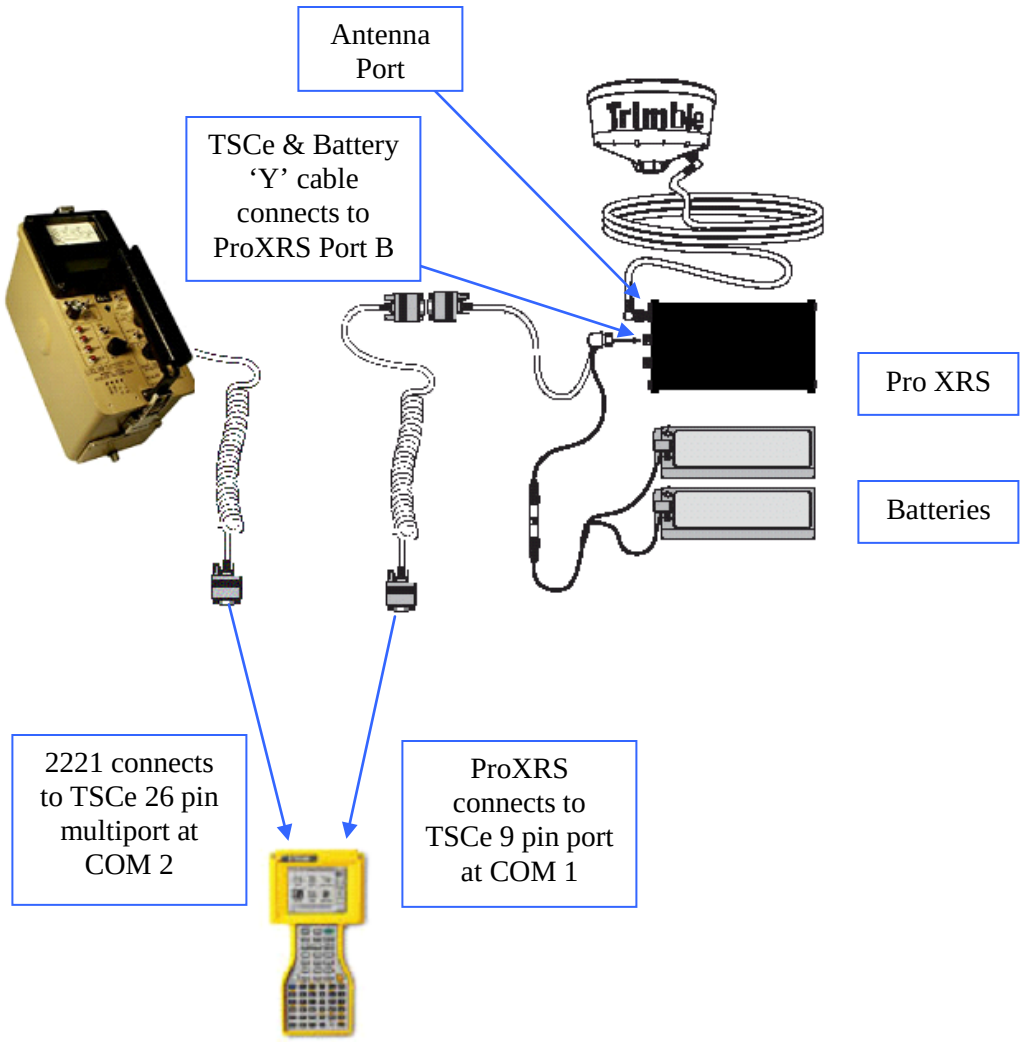
3.1.5 Ludlum 2221 scaler/ratemeter with RS-232 output

3.1.6 Ludlum 44-10 probe (or some other detector).

3.1.7 All necessary cables

3.2 Cabling Setup

3.2.1 Note: Refer to Figure below for an example of proper cable configuration associated with the GPS receiver, datalogger, and 2221 integration.



3.2.2 Connect the GPS receiver data/power 'Y' cable to port B of the Pro XRS receiver. Nothing connects to port A.

3.2.3 Connect the antenna cable to ANT port of the Pro XRS receiver.

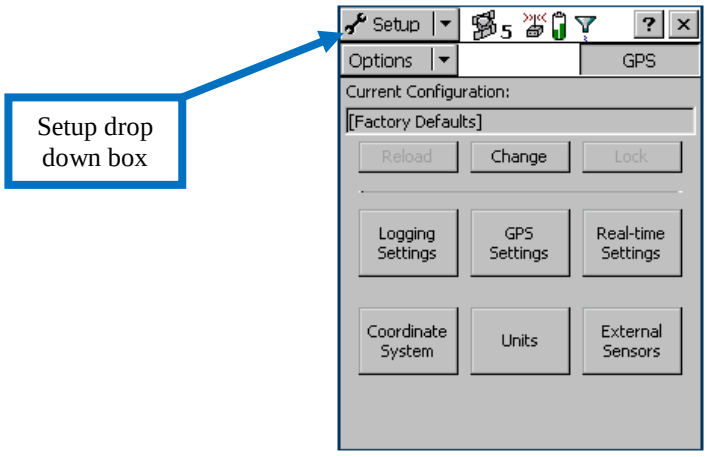
3.2.4 Connect the ProXRS receiver data output half of the data/power 'Y' cable to the TSCe COM1 port.

3.2.5 On the Ludlum 2221 connect the RS-232 data output cable to the TSCe COM2 port. You will have to use the DB9 to DB26 adaptor to connect to the TSCe COM2 port.

3.3 TSCe Setup

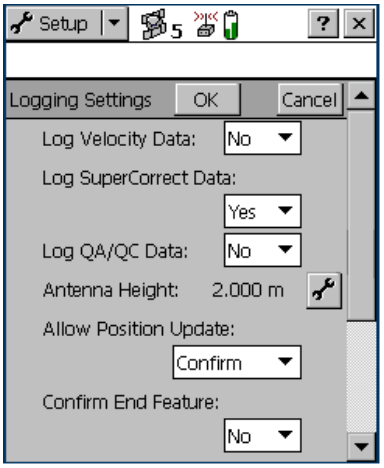
3.3.1 Turn on TSCe and open TerraSync. TerraSync is the Trimble application which communicates with the GPS receiver connected to TSCe, allowing you to set GPS parameters in the receiver, record GPS positions, and update existing GIS data.

3.3.2 From the opening window use the stylus and navigate to and tap the '**Setup'** drop down box in the upper left hand corner of the screen.



3.3.3 **Logging Settings**. Change the settings to the following:

Log Velocity Data:	No
Log SuperCorrect Data:	Yes
Log QA/QC Data:	No
Antenna Height:	2.000 m
Allow Position Update:	Yes
Confirm End Feature:	No
File name Prefix:	R
Style:	Time
Interval:	1s



3.3.4 You can change the setup option for the antenna by tapping the wrench icon next to Antenna Height. Change settings to the following:

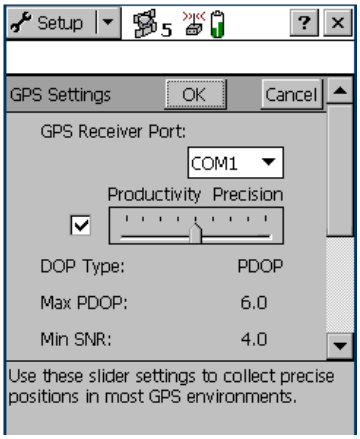
Height: 2.000 m

Confirm: Never

Type: Unknown External

3.3.5 **GPS Settings**. Change the settings to the following:

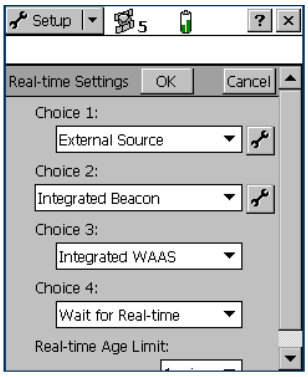
GPS Receiver Port:	COM1
Slider Check Box:	√
Position on slider bar:	5 (mid-range) - This will result in a maximum PDOP of 6.0, a maximum



SNR of 4.0 and a minimum elevation of 15°.

Velocity Filter: Auto

3.3.6 **Real-time Settings**. Change the settings to the following:



Choice 1: Integrated Beacon

Choice 2: Integrated WAAS

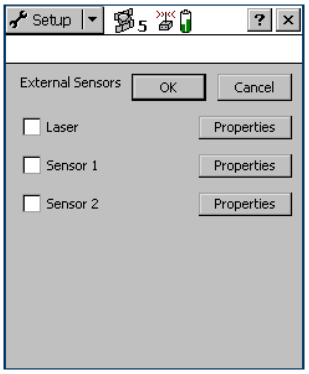
Choice 3: Use Uncorrected GPS. With this third option you will download base station data and post process receiver data after survey if necessary.

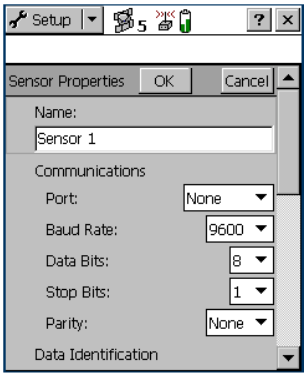
Real-time Age Limit: Leave at default value of 50 seconds

3.3.7 **Coordinate System**. Change the settings to correct coordinate system

3.3.8 **Units**. Change the units to the desired units of measure

3.3.9 **External Sensors**. Check the Sensor 1 check box and then tap Properties. Change settings to the following:





Name: Ludlum 2221

Port: COM2

Baud Rate: 9600

Data Bits: 8

Stop Bits: 1

Parity: None

Prefix: R

Suffix: \0D\0A

Max Bytes: None

Time Out: 0.10s

Receive Mode: Unsolicited

Request String: None

Point Feature: All

Line/Area Feature: All

Not In Feature: All

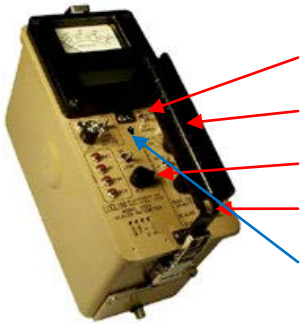
Data Destination: Uninterpreted

Attribute Name: (not displayed)

3.4 Ludlum 2221 Setup

3.4.1 Secure the RS-232 cable to 2221 handle. NOTE: The RS-232 cable is not very durable at the point where the wire housing and the metallic elbow meet. You need to tape/secure the cable to the handle to prevent premature cable shorting from causing problems with the survey data

3.4.2 Set the following 2221 switches to the following positions:



Power: ON

RESP: F

WIN: OUT

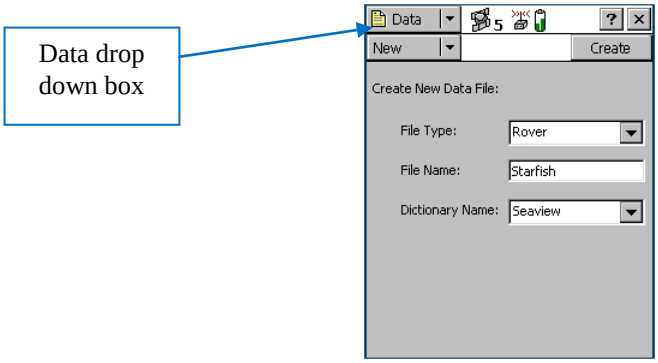
SCALER/DIG RATE: DIG. RATE

RS-232 Port

3.5 Operation

3.5.1 Opening a New File

3.5.1.1 From the opening window use the stylus and navigate to and tap the Data drop down box. Tap the Create button to create a new file.

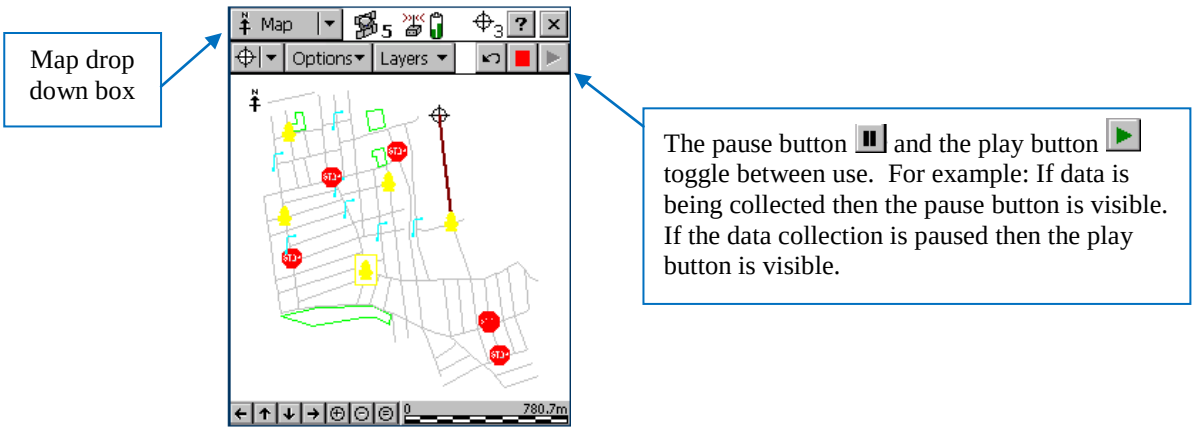


3.5.1.2 To open an existing file navigate to and tap the Existing File subsection list drop down box. Select the desired file and tap on the Open button in the upper right hand corner of the screen.

3.5.1.3 NOTE: Data collection will begin when a file is opened if TSCe and 2221 parameters are all set correctly and enough satellites are visible.

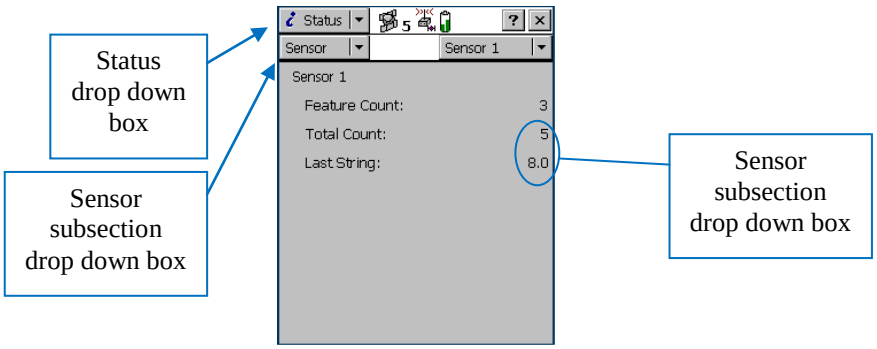
3.5.2 Pausing Data Collection

3.5.2.1 To pause data collection, navigate to the Map drop down box and tap on the pause button. To resume data collection, tap the play button.



3.5.3 Viewing Data Collection

3.5.3.1 It is advised to view data collection at the beginning of each survey to ensure all setup parameters have been set correctly and system is correctly collecting data.



3.5.3.2 To view data collection, navigate to the Status drop down box and then the Sensor subsection drop down box. The Total Count line indicates the number of gamma counts collected. The Last String line indicates the last gamma count recorded.

3.5.4 Closing Data Collection File

3.5.4.1 There are two ways to stop and close a data file. You can close the TerraSync application completely, or you can close the individual survey file and leave the TerrSync application running.

3.5.4.1.1 To close the TerraSync application completely, tap the in the upper right hand corner.

3.5.4.1.2 To close only the survey file, navigate to and tap the Data drop down box and then tap the Close button.

3.5.4.2 **Note**: If the TSCe is shut off without closing the file and closing TerraSync, the data collection file could be corrupted. If the TSCe battery is running low,

the user should perform the above steps to save and close the file and charge the TSCe so as to prevent data corruption.

3.6 Useful Information - Below are some useful tips picked up along the way. It is advised the operator read this section as you'll likely encounter some of these situations during a survey.

3.6.1 Tape your camcorder battery clips to the camcorder batteries. They'll come off during a survey if you don't

3.6.2 Do not start a survey file unless you are in the survey area and your 2221 is turned on. You may collect erroneously low gamma counts if you wait to turn your 2221 on after you start a survey file

3.6.3 If you do not see any gamma counts being collected make sure that A) the 2221 is turned on, and B) the 2221 is in the DIG. RATE mode.

3.6.4 If you acquire no satellites after waiting one minute check antenna cabling or make sure you have connected through the TSCe Setup screen

4. TRAINING

4.1 Prior to use in the field, all personnel must show proficiency in the operation the GPS and associated Ludlum hardware.

4.2 Prior to use in the field, all personnel must show proficiency in use the Trimble software.

4.3 Prior to personnel being assigned to the field, supervisor must sign off of the Training Qualifications Form that he/she met requirements 4.1-4.2 above.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.03)

5.2 Computer generated files will be saved as print and electronic files and stored with field notebooks.

6. REFERENCES

6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 4.03

Form 4.00 Training Qualification Form

7. ATTACHMENTS

7.1 None.

Author's Signature:	Reviewed By:
Charles P. Farr	Kenneth R Baker

STANDARD OPERATING PROCEDURE 5.12
DOWNLOAD, CORRECTION, AND EXPORT OF GPS SURVEY DATA

1. PURPOSE

The purpose of this procedure s to instruct the user on how to: (1) properly download survey data from a Trimble TSCe datalogger, (2) differentially correct the survey data by post process method, and (3) export the survey data into an ArcMap shapefile format for use in ESRI ArcMap GIS

2. DISCUSSION

After GPS data has been collected the data must be transferred from the datalogger to a computer running the Trimble Pathfinder Office (PFO) application. PFO will be necessary for downloading, exporting, and correction of all survey files. Once downloaded the survey data can be differentially corrected, if need be, and exported into a file format usable by the ESRI ArcView GIS application known as a shapefile. In most cases the survey data will be collected with the differential correction applied in "real time" (as the data is collected) and the correction step will not be necessary. If the survey is performed in a location where "real time" collection is not possible then this step will be necessary.

It is important to create the necessary directories in Windows Explorer before beginning a project. This will help keep data organized through the entire GPS survey project process. Further information regarding directory organization is discussed in SOP 5.01

3. PROCEDURE

3.1 Creating a New Project or Opening an Existing Project

3.1.1 NOTE: When creating a new project, it is necessary to also create a new project folder with subfolders to keep all of the files properly organized. As projects get larger they become very complicated.

3.1.2 In Windows Explorer navigate to the project directory folder and create the following folders in the following folder structure. The raw survey files (.ssf file format) will be kept in the GPS folder directly. There is no need for a subfolder because each survey file will have its own unique name based on the survey date and time. If using more than one GPS unit in a survey you should change the name of the survey files to reflect so. As an example you might change the first GPS unit

file name to end in the letter A and change the second GPS unit file name to end in a B, and so on.

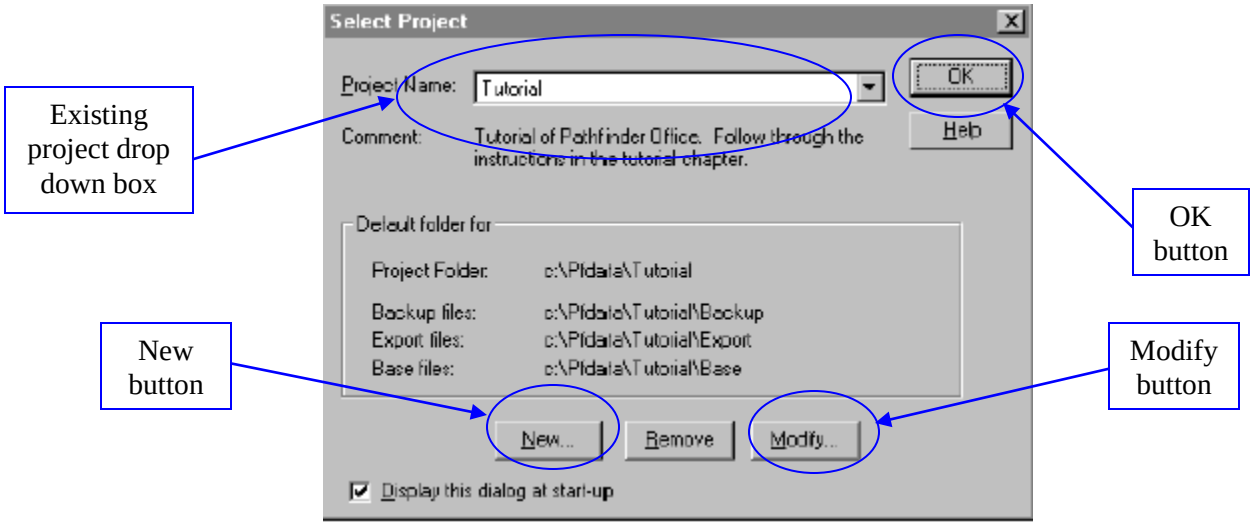
3.1.3 Under the Export subdirectory a folder for each day that a survey is performed and exported will be created. Five files will be created when the export utility is used (dbf., shx., shp., txt., and a setup information file)

3.2 Creating New PFO Project

3.2.1 Open the PFO application by locating and double clicking on the icon on the computer desktop or in the GPS Pathfinder Office folder

3.2.2 If the Select Project window does not appear when the application is started then open the **File** menu and select the **Projects** option. A new window will appear in the office window titled Select Project shown below.

3.2.3 If you are creating a new project select the New button. If you are working in an existing project then using the drop down box choose the correct project and select the OK button.



3.2.4 Select the modify button and set the correct locations for the Project folder, Backup Files, Export Files, and Base files

3.2.5 It is necessary to choose the project coordinate system when beginning a project. Open the **Options** menu and select **Coordinate System**. Using the drop down boxes select the correct coordinate system. The standard datum and units for that system will be chosen automatically but you can change them if necessary.

3.3 Download of Survey Data

3.3.1 Connect TSCe to computer running PFO using the 26-pin multiport adaptor

3.3.1.1 Attach the 26-pin multiport adaptor end to the TSCe. Connect the USB cable to the computer running PFO. Turn on TSCe

3.3.1.2 A Microsoft ActiveSync window will open up and ask about setting up a new partnership. The correct answer is No, do not synchronize data. Set up the device as a guest

3.3.1.3 If ActiveSync doesn't open up immediately then unplug USB cable and reattach. If still no connection then refer to the TerraSync Users Manual Troubleshooting section

3.3.2 Open the PFO application and select the correct project to open

3.3.3 Open the Data Transfer utility by locating and selecting the  icon or from the **Utilities** menu select the **Data Transfer** option.

3.3.4 Make sure the device is set to 'GIS Datalogger on Windows CE' and select the connect button. When connected select the Add button and choose the desired files to transfer from the TSCe to the computer running PFO. Select the Transfer All button.

3.3.5 Survey data should now be transferred to the folder chosen in Project Setup

3.4 Correction of Survey Data

3.4.1 Most survey data collected will be collected in "real time", meaning the data is differentially corrected as it is collected. If this is the case then you will not need to correct the data again. You will know the data is collected in "real time" if you see a satellite image on the TSCe screen while collecting data. The following figures are examples of images you will see on the TSCe screen indicating "real time" corrections are taking place:

DGPS Beacon Service: 

DGPS Subscription Service (OmniStar): 

WAAS Correction: 

3.4.2 Open the Differential Correction utility in PFO by locating and selecting the  icon or from the **Utilities** menu select the **Differential Correction** option.

3.4.3 If correcting only one file then the last file downloaded using the Data Transfer utility should appear in the 'Rover Files: Selected Files' field as default. If multiple rover files need to be corrected then select the browse button, navigate to and select the uncorrected files.

3.4.4 Specify the location of the base files. Depending on the source of the base files, there are three options: Local Search for base files, Internet Search for base files, or

Browse. The typical base file will be downloaded from the internet. Choose Internet Search.

3.4.5 Choose the necessary base station location from the Base Data Provider drop down box and select the OK button. The closest base station to the survey location should be chosen. After the base station data has been downloaded it will appear in the 'Base Files: Selected Files' field by default.

3.4.6 The Corrected Files: Output Folder field should default to the GPS project folder where the survey files have been downloaded to. If another folder is to be used for the corrected file storage then select the browse button and navigate to that location.

3.4.7 Select the OK button in the upper right corner of the Differential Correction window to complete the correction process. The chosen rover file(s) will be corrected using the chosen base file(s) and saved to the chosen output folder

3.5 Exporting survey data into shapefile format

3.5.1 Open the Export utility in PFO by locating and selecting the  icon or from the **Utilities** menu select the **Export** option

3.5.2 If exporting only one file then the last file downloaded using the Data Transfer utility should appear in the 'Input Files: Selected Files' field as default. If that file was differentially corrected then the corrected file will be the default file to export. If multiple files are to be exported then select the browse button and navigate to and select the desired files

3.5.3 The project export folder should be the default for the Output Folder field. The export files are all named the same during the export process so a subfolder is needed. At the end of the output folder field add the date in MMDDYY format. Example: C:\ERG\Project\ GPS\Export\MMDDYY.

3.5.4 Select 'Sample ESRI Shapefile' Setup from the 'Choose an Export Setup' drop down box.

3.5.5 The coordinate system the files will be exported in is the same as the project coordinate system set in step 3.1.2.5 above. If this needs to be changed it should be done so before exporting

3.5.6 Select the Properties button and change the following parameters.

3.5.6.1 Data tab:

3.5.6.1.1 Type of Data to Export choose the 'Features - Positions and Attributes' and from the drop down box select 'Export All Features'

3.5.6.1.2 Create Point Features From: check the box for 'Sensor Records'

3.5.6.2 Attributes tab:

3.5.6.2.1 Under General Attributes – All Feature Types check the boxes for 'Date Recorded' and 'Time Recorded'

3.5.6.3 Position Filter tab:

3.5.6.3.1 Select the 'Filter by GPS Position Info' option

3.5.6.3.2 Uncheck the boxes for 'Include Positions That Are – Uncorrected' and 'Include Non-GPS Positions'.

3.5.6.4 Coordinate System tab:

3.5.6.4.1 Select the 'Use Current Display Coordinate System' and choose the 'export coordinate as: XY'. If you choose XYZ and do not have Spatial Analyst installed on ArcView GIS you will not be able to edit the data

3.5.6.4.2 NOTE: If you choose XYZ (point Z) you will not be able to merge data with XY (point) data. If you choose XY you will not be able to merge data with XYZ. It is therefore important to be consistent in this regard.

3.5.7 Select the OK button in the upper right corner of the Export window to complete the export process. The chosen rover file(s) will be exported into the chosen format and saved to the chosen output folder

3.6 Converting String Data Into Number Data

3.6.1 With the ArcMap software and the shapefile added, open the attribute table

3.6.2 Select 'Add New Field…' under the **Options** menu.

3.6.2.1 Title the new field 'Gamma' and select the type to be long (integer).

3.6.2.2 Right click on the new field 'Gamma' and select 'Field Calculator.'

3.6.2.3 In the window below **[Gamma] =** type in (or select) **[Text]**.

3.6.2.4 NOTE: Some times the string data will not convert into number data. If there are any characters other than numbers there will be an error because non numeral string data (any character other than the numbers 0 – 9) can not be converted into numbers. You will have to scan through and remove these data records before the entire data set can be converted. This tends to happen when there is a poor RS-232 connection due to a loose connection or bad cable

4. TRAINING

4.1 There is no specific training pertinent to this SOP.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.03)

5.2 Computer generated files will be saved as print and electronic files and stored with field notebooks.

6. REFERENCES

6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 4.03

7. ATTACHMENTS

7.1 None

Author's Signature:	**Reviewed By:**
Charles P. Farr	Kenneth R Baker

STANDARD OPERATING PROCEDURE 5.13
PERFORMING GPS RADIOLOGICAL SURVEYS BY VEHICLE

1. PURPOSE

To describe the daily task for the radiological surveying with and operation of the site survey vehicle.

2. DISCUSSION

Oftentimes the scale of radiological surveys needed make their completion on foot difficult. Where site conditions allow it, completion of such surveys by vehicle are a possible alternative. The decision to utilize vehicle based surveys (as opposed to other survey methods) will typically be make by the project management team prior to deployment in the field.

3. PROCEDURE

3.1 Equipment

3.1.1 Typical GPS Radiological Survey Setup (see SOP 5.11)

3.1.1.1 It is possible to operate multiple GPS setups on a single vehicle. In this case, the equipment should be complete for each individual setup.

3.1.2 12’ C-C cable (to replace curly-C cable)

3.1.3 Extended antenna cable (to replace standard antenna cable)

3.1.4 Site vehicle equipped with detector bracket(s)

3.2 Operation

3.2.1 To achieve proper data coverage drive vehicle at a speed similar to a fast paced walk. This is can be accomplished by allowing vehicle to idle along in 4WD-Low or “granny gear”. Note that driving a four-wheel drive vehicle with the front differential engaged (i.e., in four-wheel drive) while on hard surfaces such as gravel or pavement will cause changes in the way the vehicle handles. Specifically, it may become more difficult to steer and maneuver the vehicle.

3.2.2 Have someone walk at 9 feet to side of vehicle and place pin flags or spray paint on ground at intervals easily seen by driver. When vehicle makes next pass by, driver should attempt to pass probe over marked line. This allows data to be taken in consistent pattern

3.2.3 Proper planning will allow for an area to be completely surveyed within a given time. It is less desirable to start a large section on one day and finish on another

4. TRAINING

4.1 Prior to use in the field, all personnel must show proficiency in the operation the associated GPS and radiological monitoring equipment.

4.2 Prior to use in the field, all personnel must demonstrate the knowledge of safe vehicle operation.

4.3 Prior to personnel being assigned to the field, supervisor must sign off of the Training Qualifications Form that he/she met requirements 4.1-4.2above.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.03)

5.2 Computer generated files will be saved as print and electronic files and stored with field notebooks.

6. REFERENCES

6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 4.03

Form 4.00 Training Qualification Form

7. ATTACHMENTS

7.1 None.

Author's Signature:	**Reviewed By:**
Charles P. Farr	Kenneth R Baker